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**A WALRUS AND A SEA LION
FROM THE PLIOCENE PURISIMA FORMATION
AT SANTA CRUZ, CALIFORNIA:
WITH REMARKS ON THE TYPE LOCALITY
AND GEOLOGIC AGE OF THE SEA LION
DUSIGNATHUS SANTACRUZENSIS KELLOGG**

By EDW. D. MITCHELL, JR.



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DAVID K. CALDWELL

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A WALRUS AND A SEA LION FROM THE PLIOCENE PURISIMA
FORMATION AT SANTA CRUZ, CALIFORNIA:
WITH REMARKS ON THE TYPE LOCALITY
AND GEOLOGIC AGE OF THE SEA LION
DUSIGNATHUS SANTACRUZENSIS KELLOGG

By EDW. D. MITCHELL, JR.¹

ABSTRACT: Pinniped postcranial bones are described from the Pliocene Purisima formation exposed along the coast at Santa Cruz, Santa Cruz County, California. An odobenid related to the living walrus is represented, as well as an otariid that resembles *Zalophus*. This is the first Tertiary assemblage containing both odobenids and otariids. The type locality of *Dusignathus santacruzensis* (another otariid) which is known from the same area is restricted and its age assignment is changed from Miocene to Pliocene.

Notwithstanding the amount of material described from the North American Tertiary sequence, the history of the order Pinnipedia is still imperfectly known in this area. Problems involving identity of early pinniped stocks, biphyletic origins, and basic points in the spacial and temporal distribution of the three pinniped families remain to be solved. The present paper contributes information to the last of these problems.

Specimens of the family Otariidae (sea lions) are confined to the Tertiary of the northern Pacific Ocean. The family Odobenidae (walruses) is represented in the Tertiary of both the north Atlantic and the north Pacific Oceans. Both of these groups of fossil pinnipeds are poorly represented in the geologic record, but this may be more a result of prospecting methods than an actual condition. The occurrence of pinnipeds along former strand lines which today are notorious for conditions which scatter and abrade skeletons may account for the common absence of associated skeletal elements. As a result, about half of the extinct genera of odobenids are represented by a variety of bones, and in the otariids only *Allodesmus*, *Atopotarus*, and *Pithanotaria* are known from partial skeletons.

Downs (1956) has emphasized that the study of the history of pinnipeds is still at the descriptive level. It seems pertinent, then, to describe and comment on remains of pinnipeds from a single geological formation along the coast of central California. Three species are represented by well preserved fossils: a possibly new genus and species of walrus; a specialized sea lion resembling *Zalophus*; and *Dusignathus santacruzensis* Kellogg, another specialized sea lion.

COMPARATIVE MATERIAL

The following abbreviations are used herein: LACM, Los Angeles County Museum; DRD, Donald R. Dickey Collection, University of Cal-

¹Research Assistant in Vertebrate Paleontology, Los Angeles County Museum; and Department of Zoology, University of California, Los Angeles.

ifornia, Los Angeles; and UCMP, University of California Museum of Paleontology, Berkeley. Bones of the following specimens were studied or used in direct, descriptive comparisons in the text of this paper: *Odobenus rosmarus*, DRD 15306; *Allodesmus kernensis*, LACM 4320; *Otaria byronia* (casts), LACM M1611; *Eumetopias jubata*, LACM M550; *Zalophus californianus*, LACM M658; *Arctocephalus philippii*, LACM M1114; and *Dusignathus santacruzensis*, UCMP 27121 (holotype).

DESCRIPTION OF SPECIMENS

Order PINNIPEDIA Illiger, 1811

Superfamily OTARIOIDEA Smirnov, 1908

Family Odobenidae Allen, 1880

Odobenid, possibly new genus and species.

MATERIAL. LACM 3011, parts of an associated right antebrachium and manus, including the following: ulna, radius, cuneiform, unciform, trapezoid, metacarpals 4 and 5, and the proximal ends of metacarpals 1 and 3. See Table 1 for measurements of these bones .

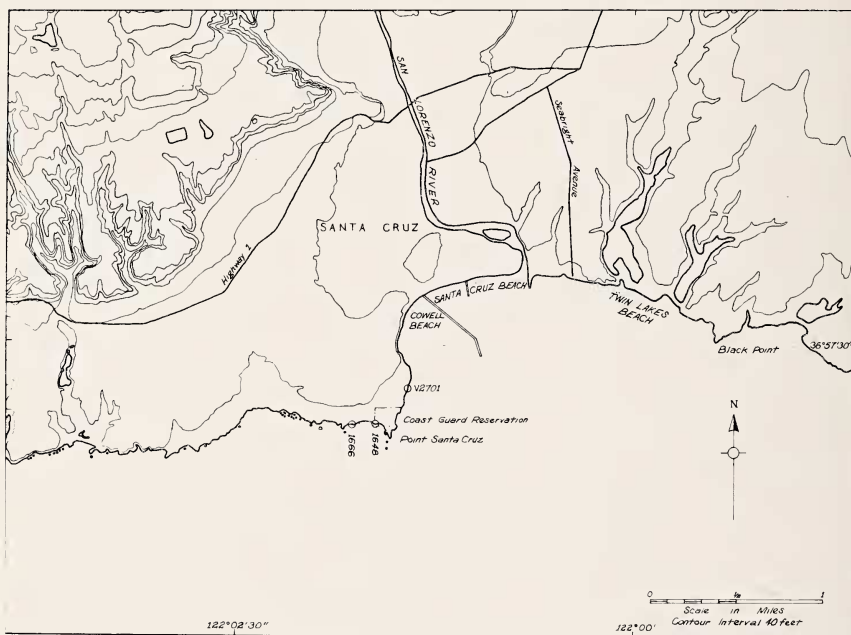


Fig. 1. Map of a portion of Santa Cruz and Soquel Quadrangles, Santa Cruz County, California, showing LACM fossil vertebrate localities 1648 and 1666, and pertinent landmarks. LACM fossil vertebrate locality 1181, the locality of the Santa Cruz odobenid (LACM 3011), is very close to or may be synonymous with locality 1666. Seabright Avenue is shown for reference, but other streets are omitted.

LOCALITY. LACM locality 1181 (Fig. 1), approximately 1100 feet west of the light beacon on the U.S. Coast Guard Reservation on Point

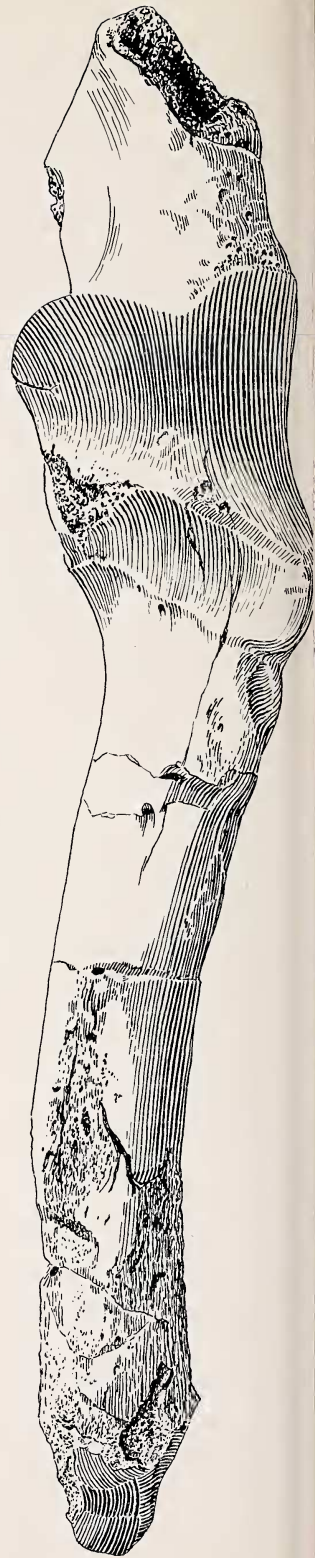
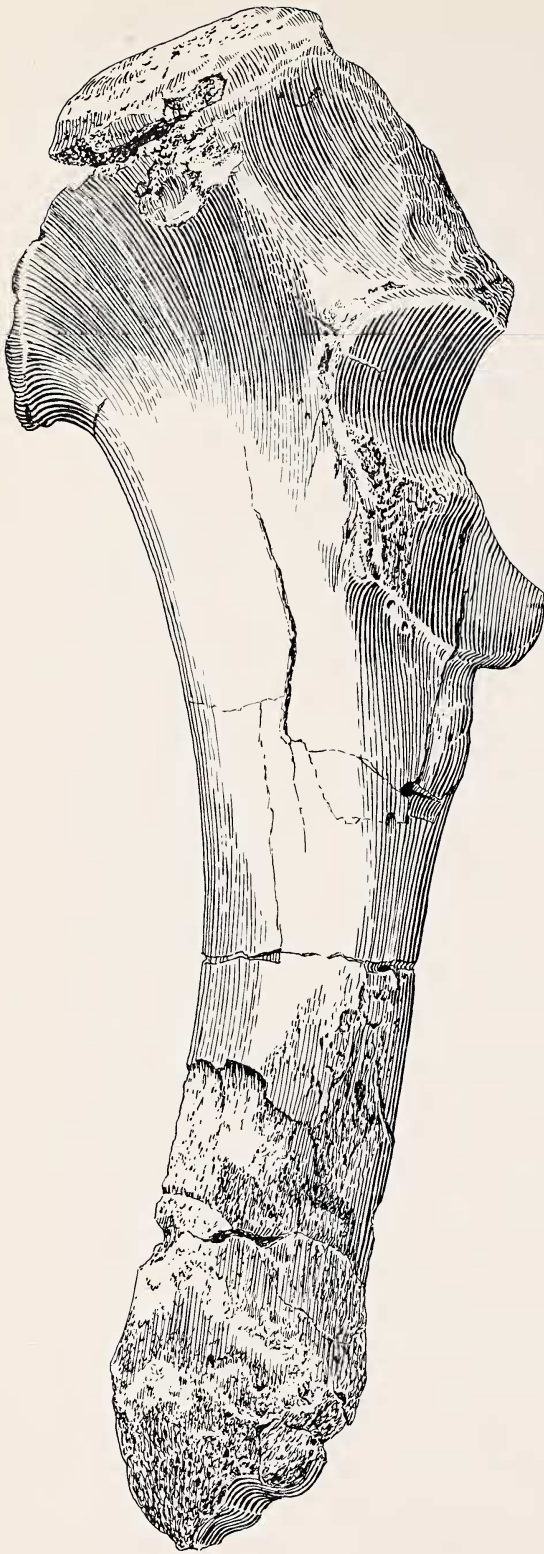
Santa Cruz, Santa Cruz County, California. Approximate longitude 122° 1' 47" West. Santa Cruz Quadrangle, USGS 1954. The bones were "associated in a single boulder or concretion which had split across" (F. A. Jenkins *in litt.* to T. Downs, 16 September 1956) before being discovered on the beach near some sea caves. The boulder had fallen from a spot in the sea cliff about ten feet above the beach (Jenkins, personal communication 1962).

FORMATION AND AGE. Purisima formation, Pliocene (see *Formation and Age* discussion of *Dusignathus*, this paper).

COLLECTOR. Rev. Floyd A. Jenkins, S. J., Loyola University of Los Angeles. Collected about 1956.

DIAGNOSIS. Ulna, radius, and fibula about 10% shorter than *Odobenus*, metacarpals also short, trapezoid small relative to size of unciform and cuneiform. Ulna with strong olecranon and coronoid processes, semilunar notch of large diameter. Radius quadrate in cross section at distal end, neck long and well defined from head, shaft does not flare medially on anteromedial border, pronator teres process distally placed. Metacarpal 1 bowed externally at distal end.

DESCRIPTIONS AND REMARKS. **Ulna.**—The right ulna (Fig. 2) is nearly complete, lacking only anterior and posterior margins of the olecranon crest and lamellar chips on the lateral side of the distal end. The shortness and massiveness of the bone is impressive. The semilunar notch is laterally narrowed and dorsoventrally elongate and shallow, resembling *Allodesmus kernensis* and *Odobenus rosmarus*. It may be distinguished from *Allodesmus*, however, in the possession of a very high olecranon and its overall shortness and massiveness. The epiphyseal portion of the ulnar process is missing, and at this point the posterior border of the shaft does not curve back as far as in sea lions, but resembles *Odobenus*. A notable feature in the fossil ulna is the nearly complete obliteration of the crest running from the radial process to the lateral margin of the semilunar notch. This crest is very prominent in all living otariids, but, significantly, is suppressed in *Odobenus*. The free dorsomedial border of the semilunar notch seen in *Odobenus* is reduced in the Santa Cruz ulna, but this is probably due to abrasion of the bone at this spot while it protruded from the sea cliff. The depressions for the flexor muscles of the digits internally and the extensor muscles externally in the posterior flange of the ulna are well developed in otariids and *Odobenus*. However, in the fossil ulna, the flange is a flat, parallel-surfaced plate about 1.3 centimeters thick with no definite concavities. This condition may indicate that extension-flexion activities played a lesser roll in the movements of this fossil pinniped. A small, rugose, raised area immediately distal to the semilunar notch is relatively larger than in *Odobenus*. The rugosity on the anterior margin of the shaft for the flexor digitorum communis 2 (see Howell, 1929: fig. 10) is much more distally placed than that found in *Odobenus*. The groove between the sty-



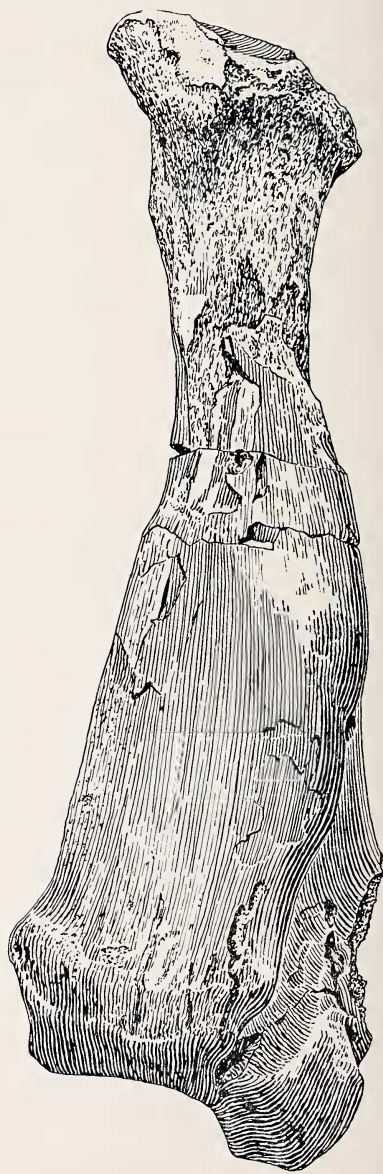
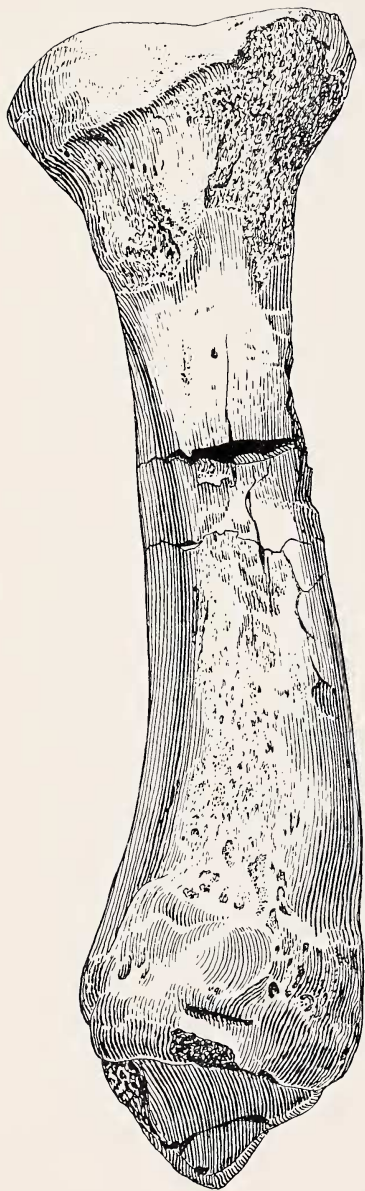
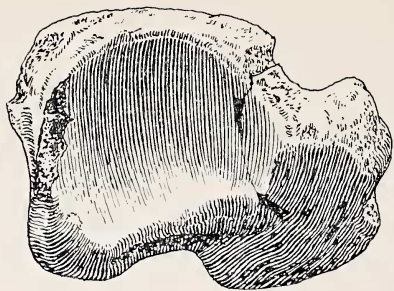
loid process and the anterior facet for articulation with the radius is very deep in *Odobenus*, less well developed in the Santa Cruz ulna, and not appreciably developed in otariid ulnae. The ulnar fragments of *Pliopedia pacifica* (Kellogg, 1921: fig. 4) differ from the ulna herein described (LACM 3011) in the following characters: the shaft is shorter anteroposteriorly at the level of the semilunar notch; the semilunar and radial notches are less expanded transversely; the distal facets for articulation with the radius, cuneiform, and pisiform are more anteriorly directed; and the tuberosity immediately distal to the semilunar notch is not well developed. Even so, there is a resemblance between the two ulnae in major proportions, and this reinforces Kellogg's (1921: 213) hesitation in referring *Pliopedia* to the Otariidae. In the size and conformation of the shaft, shape and position of the semilunar and radial notches, and olecranon shape, LACM 3011 bears a striking resemblance to *Odobenus*, but certain resemblances may also imply a close relationship to *Pliopedia*.

Radius.—The right radius (Fig. 3) is nearly complete, lacking only the anterolateral part of the capitulum and neck, and the radial process at the distal end. Here again the most characteristic feature is the shortness and massiveness of the bone. It is not so flattened laterally as in otariids, but generally resembles *Odobenus*. However, the fossil radius is even more expanded on the lateral surface than *Odobenus*, and consequently is almost quadrate rather than triangular in cross section near the distal end. The groove for extensor metacarpi pollicis is relatively narrower and shallower in the fossil radius and in *Odobenus* than in most otariids, but the extensor groove just posterior to the very large supinator longus insertion is markedly excavated from the distal end of the bone to the pronator teres process (as in *Allodesmus*). The articulation for the scapholunar is somewhat more concave and relatively smaller than in *Odobenus*, but capitular and other shaft characters are very similar to *Odobenus*. The distal articulation for the ulna is concave as in *Odobenus* rather than flat or convex as in *Allodesmus* and other otariids. The radius of *Pliopedia pacifica* (Kellogg, 1921: fig. 6) does not differ in any great respect from that of *Odobenus*, but the fragmentary state of both it and the radius described here does not allow satisfactory comparisons.

Trapezoid.—In proportion to the metacarpals and carpals, the trapezoid (Fig. 4) is about one-third smaller than that in *Odobenus* or *Allodesmus*. It approaches the typical Otariidae and *Odobenus* in shape, and differs in many characters from *Allodesmus*. The trapezoid is neither excessively widened laterally (as in *Odobenus*) nor heightened dorsally (as in *Allodesmus*) but is roughly quadrangular in distal view (as in *Zalophus*). The



Fig. 2. Odobenid, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Lateral view (left) and anterior view (right) of right ulna, two-thirds natural size.



facet for metacarpal 2 is relatively flattened compared to *Odobenus* and *Allodesmus*, and is nearly round in outline. The articulation for the trapezium is small and triangular in outline, and slightly concave anteroposteriorly. The surface for articulation with the scapholunar is nearly square in outline, essentially flat, and relatively large.

Unciform.—This element (Fig. 5) most closely resembles *Odobenus* in relative size and shape. The characters in which it deviates from the *odobenus* pattern are as follows: the ventral protuberance is more square, the dorsal protuberances are better developed, the facet for the magnum is not flat but markedly convex in center and concave at either extremity, and all the surfaces are somewhat flatter and more regular in conformation. It resembles *Allodesmus* only in this last character.

Cuneiform.—The cuneiform (Fig. 6) differs only slightly from that of *Odobenus*, and does not approximate that of any living or fossil otariid known. It is more rounded in overall proportions than that of *Odobenus*. The articulation for the unciform is triangular in outline and not clearly demarcated from the metacarpal 5 articular surface. A small pit ventral to the facet for the unciform in *Odobenus* is also present in the fossil. This pit is expanded dorsally into a triangular excavation encroaching upon the juncture of the facets for the unciform and metacarpal 5 in the Santa Cruz specimen. A sulcus limiting the antero- and posterodorsal margins of the articulation for the unciform is deeper and more regular than in *Odobenus*. The facet for the pisiform is flattened and is limited ventrally by a well delineated shoulder.

Metacarpal 1.—The right medial metacarpal is represented by a bone missing only the distal one-third of the shaft (Fig. 7). It is separable from *Eumetopias jubata* by its extreme shortness, more closely resembling *Odobenus* and *Allodesmus*. The fossil metacarpal is not so laterally expanded at the proximal end as *Odobenus*, but in most other respects resembles this genus. It can be distinguished from *Allodesmus* and all other otariids in the possession of a transversely concave articulation for the trapezium; a laterally (externally) inflected distal end; and the presence of a deep, rugose pit limited by a markedly elevated anterior margin on the dorsal, proximal surface of the shaft about one-third the total length from the proximal end. This pit is evidently for insertion of a pollical extensor (see Murie, 1871: 446, fig. 3). It is not found in any of the Otariidae, but is nearly identical to that found in *Odobenus*. Beneden (1877: pl. 7, fig. 6) figures a first metacarpal with a straight shaft under the name



Fig. 3. *Odobenus*, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Distal view (top), posterior view (bottom left), and lateral view (bottom right) of right radius, two-thirds natural size.



Fig. 4. Odobenid, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Distal (left), medial (center), and proximal (right) views of right trapezoid, two-thirds natural size.

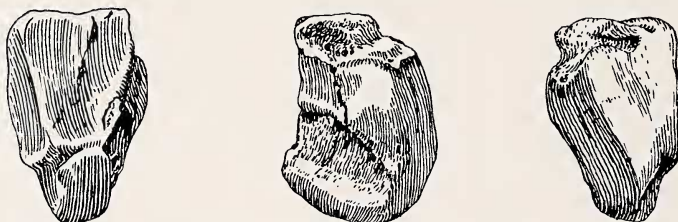


Fig. 5. Odobenid, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Distal (left), medial (center), and proximal (right) views of right unciform, two-thirds natural size.



Fig. 6. Odobenid, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Posterior (left), lateral (center), and medial (right) views of right cuneiform, two-thirds natural size.

Trichecodon koninckii which also shows this pit on its dorsal surface. No dorsal view is given for the first metacarpal of *Alachtherium cretsii*, but Beneden (1877: pl. 2, fig. 6) gives a ventral view which shows that it has a straight shaft. In specimen LACM 3011, the proximal, lateral articulation for metacarpal 2 is well rounded and indistinct, not flattened and well delineated as in *Odobenus*. Slight differences are also seen in the shape and extent of the articulation for the trapezium, the presence of large foramina on the medial border of this articulation, and the shortness of the fossil

bone. A proximal end fragment of the first metacarpal of *Pliopedia pacifica* (Kellogg, 1921: fig. 7) has a shallow depression on the dorsal face of the shaft, and the articulation for the trapezium is markedly concave transversely.

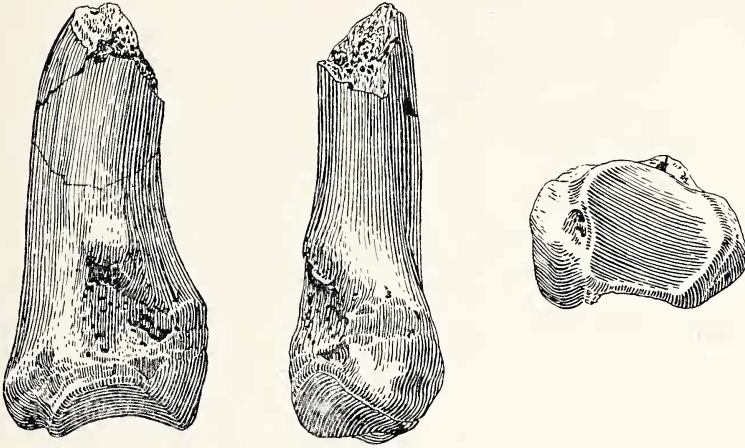


Fig. 7. Odobenid, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Dorsal (left), lateral (center), and proximal (right) views of right metacarpal 1, two-thirds natural size.

Metacarpal 3.—This element (Fig. 8) is represented by a badly weathered and broken proximal end fragment from the right manus. It resembles *Odobenus* in having a rounded, laterally flattened proximal end with generally indistinct articular surfaces. There is a large excavation ventrolateral to the metacarpal 2 articular surface as in *Odobenus*.

Metacarpal 4.—The lateral, proximal edge of this bone (Fig. 9) is broken off, but it resembles *Odobenus* in the position and conformation of the remaining articular facets. The shaft is very massive, arched dorsally, and subtriangular in cross section. The metacarpal as a whole is relatively shorter and more robust than that of *Odobenus*. The facets for reception of metacarpal 3 and the magnum project far medially, giving much larger articular surfaces than in *Odobenus*. The proximal, dorsal surface for reception of the unciform is wide and flat.

Metacarpal 5.—In comparison to *Odobenus*, which it most closely resembles, this metacarpal (Fig. 10) is shorter and the shaft is dorsally arched. The proximal end is not so bulbous but is dorsoventrally flattened; and the articulation for the unciform is flat, elongate, and more crescentic in outline. The articulation for the cuneiform is almost at right angles to the facet for the unciform, and is also more flattened and elongate. A small

pit is present just anterior to the facet for the unciform on the dorsal, external margin of the shaft. Because of the flat articular surfaces, the overall impression is one of lessened mobility of this digit at the proximal end.

Odobenid, possibly new genus and species, referred specimen.

MATERIAL. LACM 4342, a complete right fibula, with only the proximal end imperfectly preserved. See Table 2 for measurements.

LOCALITY. LACM locality 1666 (Fig. 1), "Two miles north of Santa Cruz beach, near Seal Rock" (original label). Seal Rock is the southernmost of two small rocks shown on the Santa Cruz Quadrangle, USGS 1954, less than one mile south of Santa Cruz Beach. The collector, Mrs. Virginia Hazen, accompanied me to the original locality, which is at longitude $122^{\circ} 1' 47''$ West, about 750 feet west of LACM locality 1648. Additional bones of this individual were not located although I prospected the sea cliffs in that vicinity.



Fig. 8. *Odobenid*, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Lateral view of proximal end of right metacarpal 3, two-thirds natural size.

FORMATION AND AGE. Purisima formation, Pliocene. (See *Formation and Age* discussion of *Dusignathus*, this paper).

COLLECTOR. Mrs. Virginia Hazen, September 1959.

REMARKS. The fibula (Fig. 11) is nearly identical to that of *Odobenus rosmarus* in shape but is relatively shorter and heavier. Almost the entire anteromedial portion of the proximal end is broken away, but a piece of a definite articular surface remains, indicating that the fibula was not fused proximally with the tibial head as in the *Odobenus* specimens available. Probably not much weight should be placed on this apparent distinction between the fossil and *Odobenus* fibulae, for tibiofibular fusion is an individual variation independent of age and sex in at least two living otaroid genera (*Eumetopias* and *Zalophus*). The few specimens of *Otaria* and *Arctocephalus* available for study show fusion of these elements. Lyon (1937: 153) indicated that tibiofibular fusion did not occur in *Callorhinus* bones from the Point Mugu shellmound. A small separate fragment of bone from the proximal end of LACM 4342 indicates the articulation was

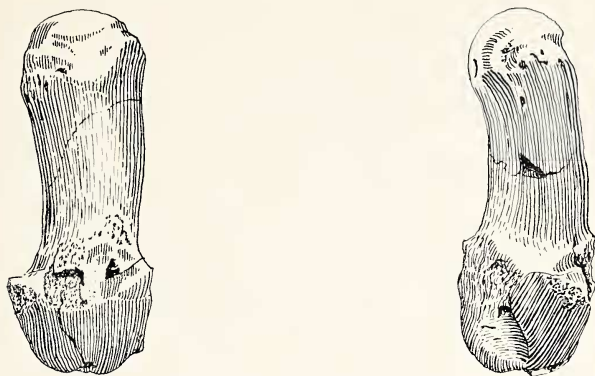


Fig. 9. *Odobenid*, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Dorsal view (left) and medial view (right) of right metacarpal 4, two-thirds natural size.

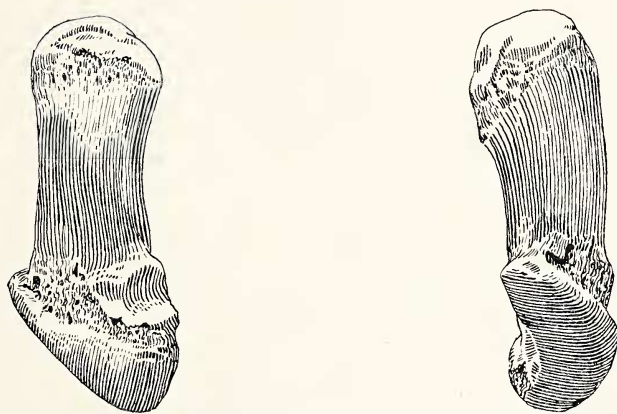


Fig. 10. *Odobenid*, possibly new genus and species, LACM 3011. LACM locality 1181, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Dorsal view (left) and medial view (right) of right metacarpal 5, two-thirds natural size.

large and flat, and that the posteromedial corner of the end was well rounded. The proximal extremity of the shaft is well rounded and not flattened as in *Odobenus*. The total length of the fossil is about 10% shorter than *Odobenus*, although both are essentially the same size and shape at each end. A ridge on the distal, internal border of the shaft is well developed in the fossil, but decidedly more so in *Odobenus*, here being

Table 1

Measurements in centimeters or degrees of bones of the Santa Cruz odobenid, specimen LACM 3011. Approximations are in parentheses.

Right ulna:

Greatest length	29.7
Length, styloid process to dorsal border of semilunar notch	25.2
Functional length, middle of semilunar notch to styloid process	21.8
Greatest dorsoventral (internal) length of semilunar notch	6.5
Greatest lateral width of semilunar notch	5.2
Greatest lateral width of shaft below semilunar notch	2.9
Greatest anteroposterior diameter of distal end of shaft	5.0
Radius of curvature of semilunar notch	3.9

Right radius:

Greatest length	22.8
Functional length, concavity of capitulum to distal articulation for scapholunar	19.1
Length, pronator teres process to concavity of capitulum	(11.0)
Lateral diameter of capitulum	6.5
Depth of extensor groove posterior to supinator longus insertion	0.6
Radius of curvature of articulation for scapholunar	(2.9)
Diameter of articulation for distal end of ulna	1.6
Greatest anteroposterior diameter of distal end	7.6
Greatest lateral width of distal end	5.0
Greatest anteroposterior diameter of articulation for scapholunar	4.2

Right trapezoid:

Greatest dorsopalmar diameter	2.8
Greatest transverse diameter	1.5
Greatest proximodistal diameter	2.8
Internal angle between articulations for scapholunar and metacarpal	38°
Internal angle between articulations for scapholunar and trapezium	45°

Right unciform:

Greatest dorsopalmar diameter	4.1
Greatest transverse diameter	2.6
Greatest proximodistal diameter	2.8
Angle between articulations for unciform and metacarpal 5	102°
Angle between articulations for metacarpal 5 and metacarpal 4	116°

Right cuneiform:

Greatest dorsopalmar diameter	4.9
Greatest transverse diameter	1.7
Greatest proximodistal diameter	2.8

Right metacarpal 1:

Greatest proximal transverse diameter	3.8
Greatest proximal dorsopalmar diameter	2.8
Length, proximal articulation to distal margin of pollical extensor pit	2.8

Right metacarpal 3:

Greatest proximal transverse diameter	2.0
Greatest proximal dorsopalmar diameter	2.4
Least transverse diameter of shaft	1.5

Right metacarpal 4:

Greatest length	7.1
Greatest proximal transverse diameter	2.8
Greatest proximal dorsopalmar diameter	2.6
Least transverse diameter of shaft	1.7
Least dorsopalmar diameter of shaft	1.8
Greatest distal transverse diameter	2.4
Greatest distal dorsopalmar diameter	1.9

Right metacarpal 5:

Greatest length	7.8
Greatest proximal transverse diameter	2.1
Greatest proximal dorsopalmar diameter	3.4
Least transverse diameter of shaft	1.7
Least dorsopalmar diameter of shaft	2.0
Greatest distal transverse diameter	2.5
Greatest distal dorsopalmar diameter	2.1
Internal angle formed by shaft axis and articulation for unciform	41°
Internal angle between articulations for unciform and cuneiform	(85°)

developed into a flaring, rugose ridge. The groove for peroneus digitorum 5 is very much deeper than that in *Odobenus* and is limited on both sides by large smooth tuberosities, a character also found in *Allodesmus*. The articulation for the astragalus at the distal end is wider anteroposteriorly than in *Odobenus*. Other differences are so slight that they do not merit description. There can be no mistaking the fact that the affinities of the animal from which this bone came lie with the Odobenidae.

Table 2

Measurements in centimeters or degrees of the Santa Cruz odobenid, referred specimen LACM 4342. Approximations are in parentheses.

Right fibula:

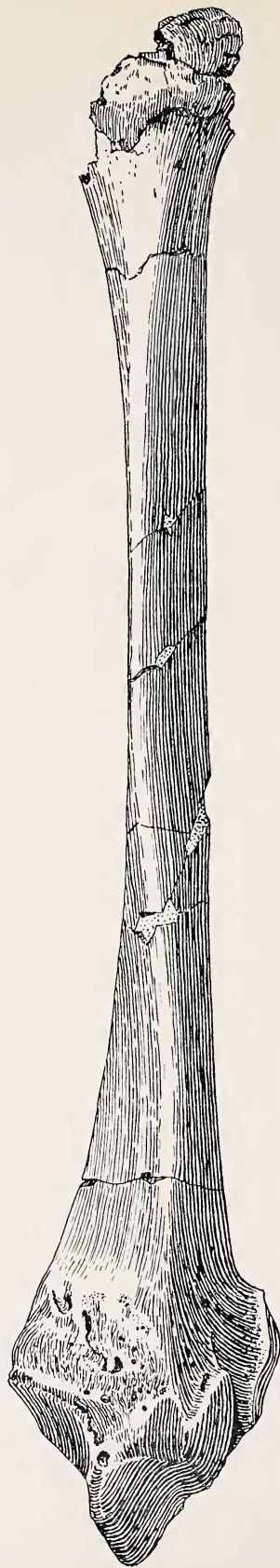
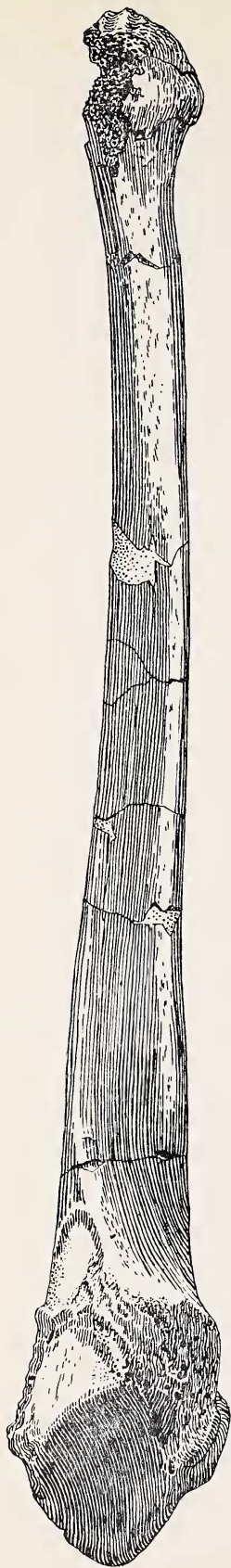
Greatest length	32.3
Greatest distal anteroposterior diameter	3.8
Greatest distal transverse diameter	6.2
Least proximal diameter of shaft	1.4
Least width of peroneus digitorum 5 groove	(1.1)
Depth of peroneus digitorum 5 groove	0.5
Angle between major plane of facet for astragalus and shaft axis	(133°)

DISCUSSION. The exact relationships of the Santa Cruz odobenid (LACM 3011, referred specimen LACM 4342) are uncertain. Tertiary odobenids are poorly known and are for the most part represented by different bones which do not allow direct comparisons between species.

The Santa Cruz odobenid is distinct from the living odobenid species *Odobenus rosmarus* (see text comparisons, this paper). *Trichecodon huxleyi* is restricted to the Pleistocene of the north Atlantic Ocean (see Ray, 1960, for summary) and differs from LACM 3011 in metacarpal 1 characters (see text comparisons, this paper).

Prorosmarus alleni is known on the basis of a single mandible from the late Miocene of the western Atlantic coast. It may prove to be congeneric with the Santa Cruz odobenid, but its greater age and Atlantic occurrence argue against this possibility.

Aside from a cryptic mention of *Odobenus* in the "latest Pliocene faunule of eastern Asia" (Takai, 1952: 185, 198) and fossil fragments of the "Atlantic" walrus recorded in the "Tertiary" near Petrovsk (Okhotsk Sea) by Ognev (1935: 344), *Valenictus imperialensis* is the only Tertiary odobenid previously known from the Pacific Ocean. The question of whether or not the Santa Cruz odobenid may be referable to the genus *Valenictus* can be resolved by an analysis of the articulation between the brachium and the antebrachium. The humerus is known for *Valenictus*, and the radius and ulna are represented in the Santa Cruz odobenid. In *Valenictus*, as far as known, the articulation is relatively small in anteroposterior diameter, poorly delineated, and with essentially no well developed coronoid or olecranon fossae; characters distinctly unlike *Odobenus*. However, in specimen LACM 3011 the articular surfaces on the radius and ulna for reception of the distal end of the humerus indicate this surface was robust,



large in anteroposterior diameter, well delineated, and probably had suitable fossae for reception of the strong olecranon and coronoid processes; characters which strongly resemble *Odobenus*. The ulna and radius of the Santa Cruz odobenid are typically odobenid, differing from *Odobenus* mostly in proportions, while *Valenictus* is a highly divergent pinniped unlike *Odobenus* in many characters (Mitchell, 1961). The Santa Cruz odobenid, then, is probably distinct from *Valenictus imperialensis*.

Two Atlantic Ocean Pliocene species of the genus *Alachtherium* must be considered. These are *Alachtherium cretsii* and *Alachtherium antverpiensis*.

A left first metacarpal of *Alachtherium cretsii* figured by Beneden (1877: pl. 2, fig. 6) has a straight and symmetrical shaft. The right first metacarpal of the Santa Cruz odobenid (LACM 3011, Fig. 7) has a shaft which is markedly bowed toward the external side, similar to *Odobenus rosmarus* and unlike *A. cretsii*. A distal end of a left ulna of *A. cretsii* figured by Beneden (1877: pl. 2, fig. 5) differs from the poorly preserved distal end of the Santa Cruz ulna (LACM 3011, Fig. 2) in proportions and placement of the flexor digitorum communis 2 rugosity and development of an accompanying ridge. A proximal end fragment of a right radius of *A. cretsii* (Beneden, 1877: pl. 4, figs. 5-6) can be directly compared to the Santa Cruz radius (LACM 3011, Fig. 3). LACM 3011 differs from the *A. cretsii* radius in having the radial tuberosity placed relatively more distal on the shaft, a more regular and possibly thinner neck, and a shaft which does not flare medially on its anteromedial border. The main differences are found in the conformation of the shaft; the other differences noted may be attributable to poor preservation of both specimens. Nevertheless, *A. cretsii* is distinct from the Santa Cruz odobenid.

A radius of *Alachtherium antverpiensis* (= *A. antwerpiensis*) figured by Hasse (1910: 6, fig. 2, no. 5) resembles that of *A. cretsii* and differs from those of the Santa Cruz odobenid and *Odobenus rosmarus* in having a thick neck which curves rapidly out to the large pronator teres process, the head not well defined from the neck, and the pronator teres process placed relatively proximal on the shaft. Hasse's illustration is poor and does not allow further comparisons, but *A. antverpiensis* is apparently distinct from the Santa Cruz odobenid.

The above remarks have shown that the Santa Cruz odobenid morphologically resembles *Odobenus* more closely than *Alachtherium*. The Santa



Fig. 11. Odobenid, possibly new genus and species, referred specimen, LACM 4342. LACM locality 1666, Pliocene, Purisima formation, Santa Cruz, Santa Cruz County, California. Medial view (left), posterior view (center), and lateral view (right) of right fibula, two-thirds natural size.

Cruz odobenid is probably related to the ancestral stock which gave rise to the living species, *Odobenus rosmarus*.

The magnitude of the differences that characterize the Santa Cruz walrus warrant its recognition as a distinct odobenid at the generic level. However, the genus is not named because directly comparable material of *Valenictus* is not available. It is barely possible that an odobenid could have evolved with a highly specialized humerus (*Valenictus*) and with a shortened but generalized antebrachium (as in LACM 3011). Additional material must be discovered to settle the issue.

Family Otariidae Gill, 1866

Otariid, aff. *Zalophus*

MATERIAL. LACM 4343, a proximal end of a right ulna, shattered during collection from the wet sea cliff. Virtually all important features of the bone are discernible. See Table 3 for measurements.

LOCALITY. LACM locality 1648 (Fig. 1), longitude 122° 1' 37" West, Santa Cruz Quadrangle, USGS 1954; five hundred feet west of the light beacon on the U.S. Coast Guard Reservation on Point Santa Cruz, Santa Cruz County, California. The locality is in the sea cliff precisely at the western boundary of the Reservation, about sixteen feet below the top of the cliff exposed in this area.

FORMATION AND AGE. Purisima formation, Pliocene (see *Formation and Age* discussion of *Dusignathus*, this paper.)

COLLECTOR. Edw. D. Mitchell, Jr., 13 May 1961. Dr. R. E. Arnal of San Jose State College expedited the prospecting by pointing out the approximate location of a previous find (LACM 4342).

DESCRIPTION AND REMARKS. The proximal end of the right ulna (Fig. 12) represents an animal about the size of a small female *Zalophus californianus*. This comparison is meaningful, for the bone differs from *Eumetopias* and *Otaria* and approaches *Zalophus* in: the shape of the radial notch; the small origin of the extensor pollicis longus muscle; and the presence of a well developed ulnar tuberosity, located on the medial side of the olecranon just anterior to the position (on the external side) of the ridge separating the origins of the extensor metacarpi pollicis and the extensor pollicis longus. However, a slight ridge running from this ulnar tuberosity to the posterior border of the shaft in *Zalophus* (figured but not commented on by Mori, 1958: fig. 9) is not present on the fossil. The presence of this ridge is variable in ulnae identified as *Arctocephalus* by G. Lyon in the Los Angeles County Museum (specimens M1114). The posterior border of the shaft is very thin and delicate. About midshaft in the fossil the shaft is concave on each side in cross section. The origins for the brachialis and flexor digitorum communis muscles are very prominent. The fossil ulna differs from that of all living otariids in having a dorsally elongate, anteriorly thin margin of the olecranon and radial process. The semilunar notch projects laterally to a greater extent and the dorsal margin



Fig. 12. Otariid, aff. *Zalophus*, LACM 4343. LACM locality 1648, Pliocene, Purisima formation, Santa Cruz County, California. Lateral view (left), anterior view (center), and medial view (right) of right ulna, two-thirds natural size.

of the semilunar notch is relatively straighter than in living forms.

It is possible that this bone may be from a specimen of *Dusignathus santacruzensis*, since postcranial bones are not known for this species. However, the relationships of *Dusignathus* are not clear. Kellogg (1927: 27) stated that his comparison of the holotype of *D. santacruzensis* with the skulls of living pinnipeds did not seem "to offer any suggestion as to the true affinities of this fossil species to existing genera of otariids."

Table 3

Measurements in centimeters of otariid aff. *Zalophus*, specimen LACM 4343.

Right ulna:

Greatest proximodistal (internal) length of semilunar notch	3.0
Greatest lateral width of semilunar notch	3.6
Anteroposterior length of olecranon	6.3
Proximodistal length between olecranon and proximal border of semilunar notch	5.9
Transverse thickness of shaft posterior to semilunar notch	0.4
Least anteroposterior diameter of shaft proximal to semilunar notch	4.7
Radius of curvature of semilunar notch	1.5

REMARKS ON *DUSIGNATHUS SANTACRUZENSIS*

In addition to the foregoing pinnipeds, associated bones of the highly specialized sea lion *Dusignathus santacruzensis* are known only from the same area. This sea lion has previously been considered late Miocene in age. The following discussion restricts geographically the type locality of *D. santacruzensis* and places it in the Pliocene Purisima formation at about the same stratigraphic level as the walrus and the sea lion described in this paper.

Dusignathus santacruzensis Kellogg, 1927, Carnegie

Inst. Wash. Publ. 346: 25-37.

TYPE SPECIMEN. UCMP 27121: right and left mandibular rami, right maxillary fragment, right squamosal fragment, portion of supraoccipital, and six loose teeth. All of the material belongs to one skull.

COLLECTOR. E. L. Furlong, 28 December 1924.

TYPE LOCALITY. UCMP V2701: "Sea cliff at a point between Seabright, a suburb of the city of Santa Cruz, and the lighthouse, Santa Cruz County, California. Near latitude 36° 58' North and longitude 122° West, Santa Cruz Folio, No. 163, U. S. Geological Survey. The specimen was found protruding from the face of the cliff about four feet above the beach sand at the base. The cliff at this locality is from 45 to 50 feet high and consists of several strata of a rather dense, fine-grained sandstone which becomes quite soft when weathered. Numerous large concretions are embedded in these sandstone layers. Some feet above, but not immediately over the spot where this specimen was found, is a long string of indurated sandstone concretions that have been broken through vertically, exposing sections of large cetacean bones" (Kellogg, 1927: 28).

The above locality description is very general on the basis of present day observations, covering about one and one-half miles of sea coast. The "Seabright" referred to is probably the small beach and surrounding community at the end of Seabright Avenue, between Twin Lakes Beach and the mouth of the San Lorenzo River (see Fig. 1).

Locality V2701 is entered on a copy of the Santa Cruz, California 15 minute quadrangle (ed. 1902, reprinted 1930) in the files of the Museum of Paleontology at Berkeley. V2701 is the locality number given to the type locality of *D. santacruzensis* subsequent to Kellogg's 1927 publication. V2701 is indicated to be about 1350 feet N 23° E of the lighthouse on Point Santa Cruz (see Fig. 1).

I prospected Cowell Beach as far south as possible, but did not reach the location of V2701 due to its present inaccessibility. No additional pinniped fossils were located, but odontocete and mysticete bones were collected. Cetacean bones are apparently quite common in the Santa Cruz sea cliffs, some of them having been discovered as early as 1827 (VanderHoof, 1951: 110).

LACM fossil vertebrate localities 1181, 1648, and 1666, and UCMP fossil vertebrate locality V2701 all occur at about the same stratigraphic level.

FORMATION AND AGE. Kellogg (1927: 27) stated that the holotype of *Dusignathus santacruzensis* was from the Santa Margarita formation. Lyon (1941:23) erroneously considered *D. santacruzensis* as Pleistocene in age. On the Santa Cruz Sheet of the Geologic Map of California (1958), the type area and other localities discussed in this paper (see Fig. 1) fall within the area mapped as "upper Pliocene" marine sediments. C. A. Hall (personal communication, 1961) informed me that he believes the rocks forming the sea cliffs in the area, on the basis of lithology and fauna, should be referred to the Purisima formation. The Purisima formation was considered middle Pliocene at its type locality by Keen and Bentson (1944: fig. 4), and early to middle Pliocene by Weaver, *et al* (1944: chart 11). However, as Dr. Myra Keen of Stanford University has pointed out to me (*in litt.*, 12 April 1962) the Purisima formation may range both downward and upward in age from that (middle Pliocene) at its type locality, and that part in the Santa Cruz embayment may be late Pliocene in age.

CONCLUDING REMARKS

A Pliocene pinniped assemblage is recognized from the sea cliffs in the vicinity of Santa Cruz, California. Three taxa are represented by well preserved bones from approximately the same stratigraphic level in these sea cliffs. They are the possibly new genus and species of odobenid; otariid, aff. *Zalophus*; and *Dusignathus santacruzensis*. The walrus was very much like the modern *Odobenus rosmarus* but with shorter bones in the forearm and manus. The otariid aff. *Zalophus* was a specialized sea lion which may

be related to the living California sea lion, *Zalophus californianus*. Although no new elements are described for *Dusignathus santacruzensis* in this study, a discussion of its type locality and age is included. *Dusignathus* was found in the same formation as the walrus (LACM 3011, 4342) and the otariid aff. *Zalophus* (LACM 4343). Previously considered by Kellogg (1927) and others to be the Miocene Santa Margarita formation, the sediments from which the holotype of *Dusignathus* came are here considered to be the Pliocene Purisima formation.

Some bones of the sea lion *Pliopedia pacifica* and the Santa Cruz walrus are very similar, and the presence of a pit on the dorsal, proximal surface of metacarpal 1 in *Pliopedia* suggests a definite odobenid relationship for this supposed otariid.

The Santa Cruz walrus, the otariid aff. *Zalophus*, and *Dusignathus santacruzensis* probably lived contemporaneously in the same geographic area. This is the first described association of both odobenids and otariids in the North Pacific Tertiary.

Although the otariid aff. *Zalophus* and *Dusignathus santacruzensis* are represented by different bones and may be conspecific, it is not unlikely that an odobenid and two distinct otariids occupied the same area. This occupation may not have been at the same time of year however. A modern example is found in the Pribilof Islands in the Bering Sea. These islands fall within the breeding range of the northern fur seal, *Callorhinus ursinus* (see Scheffer, 1958), the Steller sea lion, *Eumetopias jubata* (Kenyon and Rice, 1961), and winter strays of the walrus, *Odobenus rosmarus* have been seen in Pribilof Island waters (Fay, 1957: 435). The range of *Odobenus* in early historic times (Fay, 1957: fig. 1) overlaps considerably the present range of *Eumetopias* and *Callorhinus* (Scheffer, 1958).

The Santa Cruz walrus, living at approximately latitude 37° North in the Pliocene, may have been physiologically or behaviorally adapted to somewhat warmer climates than *Odobenus rosmarus*.

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